

### **General Remarks:**

Claims 2, 6-9 and 11-13 and 17-20 have been cancelled without prejudice of re-submission or pursuit by way of a continuation application. The subject matter of part of claim 13 has been added to claim 1. No new matter has been added by this amendment. Support for “a portion of the catalyst from the separator” in claim 13 can be found in the description of the regenerator at lines 15 through 26 of the present application. Support for “fluid bed catalyst regenerator” can be found at page 8, line 26, where US Patent No. 3,888,762 is incorporated by reference. US Patent No. 3,888,762 discloses a fluid bed catalyst regenerator.

Applicants note that the prior rejection of claim 17 under 35 USC § 112 was withdrawn by the examiner in view of the amendment filed on October 22, 2009.

### **Claim Rejections:**

Claims 1, 3-5, 10, 13, 14-17, 21 and 22 stand rejected as anticipated by Sanfilippo et al. (US 2005/0177016A1), or in the alternative, under 35 USC 103(a) as obvious over Sanfilippo et al. in view of either Ruottu et al. (US 6,045,688) or Gartside et al. (US 5,254,788). Claims 10, 13 and 17 have been cancelled, thus rendering such rejections moot. For the reasons set forth below, applicants request reconsideration of the rejection of the pending claims 1, 3-5, 10, 14-16, 21 and 22.

### **Section 102(e) Rejection**

The Examiner states that “Sanfilippo et al. discloses a process of producing a vinyl aromatic compound such as styrene by contacting a C<sub>2-5</sub> alkyl-substituted aromatic compound (e.g., ethylbenzene) in a dehydrogenation catalyst in a reaction zone to produce a hydrocarbon product comprising a C<sub>2-5</sub> alkenyl-substituted aromatic (e.g. styrene). The spent catalyst is then separated from the hydrocarbon product and passed into regeneration zone and combined with fresh catalyst and returned to the dehydrogenation reaction zone. Styrene is then recovered as a product.” The Examiner concludes that “since the process of Sanfilippo is operated at a GHSV higher than 200 NI/hlcat and residence times of the solid catalyst are less than one minute, it would be expected that the residence times of hydrocarbon and catalyst in the dehydrogenation riser and the separator would encompass the residence times as claimed.”

Applicants respectfully traverse the Section 102(e) rejection. Applicants submit that Sanfilippo discloses a reactor-regenerator device and its use in the production of styrene. [0001]. More specifically, Sanfilippo states that its invention “relates to a reactor-generator device, comprising at least one reactor for catalytic dehydrogenation reactions of hydrocarbons and at least one *regenerator of the catalyst of the fast riser type*”. (emphasis added). [0002] Sanfilippo criticizes the prior art process depicted in US 6,031,143, as using a system consisting of a reactor and a fluid bed regenerator with a flow in countercurrent of gas and solid to effect both the dehydrogenation reaction and the regeneration phase of the catalyst. Fluid beds, however, have the disadvantage of requiring large size equipment and high quantities of catalyst. [0007]

Amended claim 1 of the present application specifies that rather than a fast riser type of catalyst regenerator, a fluid bed catalyst regenerator is used. In order to anticipate the claims, one single reference must contain all of the elements of the claim. Sanfilippo thus does not anticipate amended claim 1 and the Section 102(e) rejection should be withdrawn.

### **Section 35 USC 103(a) Rejection**

The Examiner concludes that Ruottu discloses a dehydrogenation reactor wherein the total contact time of the catalyst in the reaction zone and in the separator would be about 1.4 to 2.5 seconds, and, that the dehydrogenation riser is operated at a temperature of from 100 to 1300° C. The Examiner finds that Gartside teaches a dehydrogenation process wherein the dehydrogenation reaction zone is operated at temperature of from 900 to 1600°F (482 to 871°C) and at a pressure of from 10 to about 100 psig, and concludes that the total contact time of the catalyst in the reaction zone and separator is about 0.1 to about 2 seconds.

The Examiner concludes that “It would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified the process of Sanfilippo by utilizing the dehydrogenation reactor of either Ruottu or Gartside because such reactor has a high efficiency.”

Applicants respectfully traverse the Section 103(a) rejection. Applicants submit that Sanfilippo discloses a reactor-regenerator device and its use in the production of styrene. [0001]. More specifically, Sanfilippo states that its invention “relates to a reactor-*regenerator* device, comprising at least one reactor for catalytic dehydrogenation reactions of hydrocarbons and at least one *regenerator of the catalyst of the fast riser type*”. (emphasis added). [0002] Sanfilippo criticizes the prior art process depicted in US 6,031,143, as using a system consisting of a reactor and a fluid bed regenerator with a flow in countercurrent of gas and solid to effect both the dehydrogenation reaction and the regeneration phase of the catalyst. Fluid beds have the disadvantage of requiring large size equipment and high quantities of catalyst. [0007]

Sanfilippo teaches that the reaction vessel can consist of one or more reactors for reactions which are carried out in a fluid bed where the gas rises in countercurrent with respect to the catalyst, which is descending. [0010] Sanfilippo states that, alternatively, if a sufficiently active catalyst is available, the reaction vessel can consist of at least one riser reactor operating “under fluid conditions like those of the regenerator riser”. [0011]

Sanfilippo identifies as an object of its invention a process for carrying out the catalytic dehydrogenation reaction in gas phase of ethylbenzene and/or ethane which uses the reactor-regenerator device “described above”. [0018] Sanfilippo expressly teaches that “in the case of the dehydrogenation of a *bi-component reagent gas*, such as ethane/ethyl benzene mixtures, *it is possible* to use a reactor-riser as a reaction vessel. [0024]

Thus, Sanfilippo teaches the importance of the use of a riser-regenerator. Sanfilippo suggests that in the case of the dehydrogenation of a *bi-component reagent gas*, it is *possible* to use a reactor riser as a reaction vessel in combination with the riser-regenerator.

In contrast, the process of amended claim 1 uses a reagent gas which consists essentially of the reagent gas, thus not a “bi-component reagent gas”. Further, amended claim 1 specifies that a fluid bed catalyst regenerator is used. The difference in regenerator configuration is significant. We have found that the conversion of ethylbenzene to styrene increases when regenerator time is increased, and that insufficient time in the regenerator results in an insufficiently active catalyst. For example, as set forth in the Section 1.31 Declaration of Richard A. Pierce, submitted concurrently herewith, optimum oxidation time in the fluid bed regenerator is at least four minutes and may be as long as twenty minutes. For this reason alone, Sanfilippo itself teaches away from the present invention. [0025]

Ruottu and Gartside do not remedy the deficiencies of the teachings of Sanfilippo. First, unlike Sanfilippo, they are directed to dehydrogenation reactions involving paraffinic compounds only, not alkylaromatic compounds, and certainly not bi-component reagent gases of Sanfilippo. For that reason alone, there is no motivation for one of skill in the art to combine the teachings of Sanfilippo with Ruottu and Gartside. Secondly, Gartside does not teach a *riser* reactor configuration. Instead, Gartside teaches a *downer* reactor. A combination of the *downer* reactor of Gartside with the teachings of Sanfilippo simply does not arrive at the claimed process.

Applicants request reconsideration of the outstanding rejections and allowance of the amended claims.

Respectfully submitted,

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